THE PROCEEDINGS
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THE INSTITUTION OF PRODUCTION ENGINEERS

The Official Journal of the Institution of Production Engineers

Members are requested to correspond with the Editor upon matters of general interest. Letters may take the form of descriptions of unusual plant or tools, workshop methods, production problems or organisation systems. Only in exceptional circumstances will proprietary articles be dealt with editorially. Manufacturers wishing to draw the attention of the Institution to the merits of their products are invited to use the advertisement columns of this Journal. All correspondence should be addressed to the General Secretary, Institution of Production Engineers, 40, Great James Street, Bedford Row, London, W.C.1.

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NINTH ANNUAL GENERAL MEETING.

THE ninth annual general meeting of the Institution was held in the Council Room of the Society of Motor Manufacturers and Traders, 83, Pall Mall, London, on 3rd December, 1930, at 7-30 p.m. Mr. H. E. Weatherley, President of the London Section, first presided. The notice convening the meeting having been read by the General Secretary, Mr. R. Hazleton, the minutes of the last annual general meeting and of the special general meeting of 22nd July, 1930, were read, confirmed and signed. The result of the annual elections to the Council were announced.

MR. E. W. HANCOCK, the new Chairman of Council then took the chair, and expressed his appreciation of the honour that had been conferred upon him in being appointed to this position. He spoke in terms of high praise of the manner in which Mr. Hannay, his predecessor, had acted in this capacity during his term of office as Chairman. Continuing, he said that the satisfactory growth of the Institution was obvious to all, its work was being far more widely appreciated, and the annual report for the past year confirmed these opinions which, he observed, must be very gratifying to the early members of the Institution, who carried out the initial "spade" work.

Mr. Hancock continuing, said how pleased he was to be once more in London, as this was the scene of his earlier association with the Institution, and that he would like to express his appreciation of the assistance which was given to him in the earlier days, particularly towards Mr. Hutchinson, who had done so much towards encouraging new members to take part in the discussions at some of the earlier meetings in London. He then referred to Mr. Elbourne's paper which was to follow the annual general meeting, and he regarded this as an indication of the widespread interest which the Institution was taking in all matters appertaining to production, and this particular subject was one which, until a few years ago, had never been aired before a gathering of production men. In conclusion, he pointed out that he was only too delighted to give as much of his time as he possibly could for the Institution; to do all he could to assist with the development work. He then moved the adoption of the annual report of the Council for 1929-1930.

Mr. R. H. Hutchinson, seconding the adoption of the report, also emphasised the advance which the Institution was making, and also what the Chairman had said on that matter. He felt that the future advancement of the Institution was assured, and it was all due to those who had charge of the destinies of the Institution in the early years and who had burned a good deal of midnight oil in the interests of the Institution. During the past year the Glasgow and Luton branches had been opened and were landmarks in the history of the Institution for the reason that it only remained now to cover the eastern and the western counties for the Institution to have branches all over the country. The whole of the future development of the work of the Institution was based upon a very solid foundation. He could also speak with some knowledge of the wonderful work Mr. Hannay had done for the Institution, and in seconding the adoption of the annual report he would also propose a cordial vote of thanks to Mr. Hannay.

The motion was carried unanimously.

Mr. Hutchinson, as Chairman of the Finance Committee, then moved the adoption of the accounts, and said it was extremely satisfactory that the Committee's Budget for the year had been met almost to a £.

Mr. G. H. Hales seconded, and the motion was carried.

Mr. Hutchinson moved, and Mr. A. Butler seconded, that Messrs. C. H. Appleby & Co. be re-appointed auditors.

The motion was carried.

Mr. G. H. Hales, moving a vote of thanks to the honorary secretaries of the local sections, said that having seen a great deal of the work done in the local sections, it was impossible not to recognise how much the success of the Institution was due to it and to the manner in which the local honorary secretaries carried

on their task. In starting a new section there was a great deal of work to be done. The local honorary secretaries had been guided by the General Secretary, and there was a healthy competition between the various sections, which he hoped would continue.

MR. A. BUTLER seconded.

The resolution, which was in the following terms, was carried with acclamation:

> "That the thanks of the Institution be accorded to the honorary secretaries of the various sections for their valuable and successful work during the past year, and that this vote of thanks be also conveyed to Mr. I. H. Wright, late honorary secretary to the Birmingham Section."

This closed the business of the annual general meeting.

WORKS COSTING AND PRODUCTION.

Paper presented to the Institution, London Section, 3rd December, 1930, by E. T. Elbourne, F.I.I.A.

THE title for the present paper is not of my choosing, and I am not too confident that the treatment I have adopted is what you are looking for. There is a tendency for technical men to be interested more in systems than in underlying principles. Then immediately you lay before them a definite system they find no difficulty in pointing out how entirely unsuitable it is for their particular conditions. As an approach to the subject it is about as serviceable as hoping to learn bridge design by studying only the examples published in *The Engineer* or other technical journals. As engineers, you know you must first study the fundamental principles of bridge design before you can hope to benefit seriously from examination of working drawings. When it comes to any aspect of management you pooh-pooh the idea that you need spend time on first principles. Your concern as the much belauded practical man is to get on with doing the job. If you will hear me patiently, I am hopeful I shall make some useful, if only small, contribution to your outlook as production engineers. If I am as successful as I want to be I may leave your moral courage sufficiently re-inforced for you not to be nervous when you see an accountant on the horizon. Usually, of course, when it comes to administration, it is you as a technical man who is hardly on the map, while the accountant occupies the front part of the stage. That, however, is your fault and not his, and mainly because you have not yet applied your minds seriously to the study of administrative principles. I speak bluntly only that I may help. For instance, when I wrote my main treatise on factory administration and cost accounts I did so advowedly to interpret administration jargon for the benefit of technical men in terms free of accountancy. In the process I tried to make clear factory technical conditions as they bore on administration. I think I may safely say, that the technical men declined my well-meant help and the accountants took an even stronger grip on administration. My sense of disappointment lies in my strong conviction that industry needs to be led by the creative minds of technical men. The function of the accountant is essentially to conserve and to him, imagination and vision are qualities to be viewed with the utmost suspicion. We all know how dangerous, for instance, the inventor is, not because of his inventive skill or imagination, but because of his administrative ignorance. You, as production engineers, must have the

inventive faculty strongly developed. Some of you are probably dangerously clever, but does that justify your being too proud to take administration seriously as requiring arduous preparation?

Having made you feel thoroughly annoyed, perhaps I can now turn to discussion of the principles underlying works costing as one aspect of administration.

Estimating and Costing Compared.

Although as engineers you are not likely to confuse costing with estimating, it is worth making it clear to begin with that by costing is meant the making of records of what was happening, or had happened, while estimating refers to what in certain circumstances is expected to happen. I will not stay to develop these very crude definitions. Enough if I prevent any misunderstanding on the part of those of you who may be associated with trades where costing means working out a selling price on a basis of estimated costs, and where frequently there is no organised attempt to check costs against estimates, in fact, no cost accounts, in the orthodox sense, are kept. By orthodox cost accounts I mean separate accounts of wages, materials and oncosts, dissected by departments, processes or jobs, as the case may be.

Scope of Works Costing.

I am assuming that works costing means the inclusive cost of manufacture, and does not include the cost of selling or general administration. The distinction that this calls for between manufacturing oncosts and what I may call commercial oncosts is very important.

Might I venture here to remind the production engineer that production efficiency is to be measured only in terms of the total costs of the product delivered to the warehouse. It is by no means enough to obtain efficiency in terms of direct operation times. Hence the significance of knowing how all other factors in costs of production are applied to each item of product.

One of the shortcomings of many costing systems devised with too much regard to the purely financial aspect is that manufacturing oncosts and commercial oncosts are merged. From an administrative point of view, this prevents the use of a proper technique for fixing selling prices and, hardly less serious, confuses responsibility for both profits and losses. As technical men you will know that profits are made by the commercial side and losses by the factory side. If oncosts of both are merged, who is to disprove this conclusion? Desirable as the distinction may be, it is not an altogether simple matter to effect it. An entirely logical approach is rarely to be recommended. What is wanted is to follow certain more or less obvious lines of cleavage corresponding with individual responsibilities. This is particularly important in preparing the way for budgetary control. The main items of oncosts common to both

divisions, that necessitate some degree of compromise, are building service, general administration and interest on capital.

As to building service, the commercial departments of a manufacturing business are usually housed in the same range of buildings as the factory. It is simpler, and rarely would matter if all the charges for building upkeep, lighting and heating are borne entirely as manufacturing oncosts. From the budgetary control point of view, all building service will be the responsibility of one individual, say, the works engineer, and obviously it is the sum total cost of the service to which he must address himself. What the manufacturing interests concede on this account will doubtless be recouped under other heads. For example, general administration covering, say, cost of general managers' and directors' services, have reference to both manufacturing and selling, but it will usually be convenient for the whole cost to be included in commercial oncosts.

The most difficult item to deal with is interest on money employed. It will be better not to debate the matter at any length as to whether interest on capital should in fact be treated as an item of cost. From a general point of view, particularly as to comparison of costs in differently constituted businesses (and there are other reasons), it seems desirable not to include interest on capital in manufacturing oncosts. The matter can hardly be left at that, however, and I will submit later a method of differentiating as to oncosts between machines of widely varying capital cost. With regard to the main factors of manufacturing wages, materials and oncosts, and it will be convenient now to discuss them in more detail.

Manufacturing Wages.

Manufacturing wages fall mainly into two distinct categories, viz., production wages and service wages. There is another category, viz., what may be called "capital" wages, expended on either the making of new plant or its installation. If they are to bear manufacturing oncosts, as in some circumstances they should, then they are comparable with production wages. If, as is more usual, no oncosts are charged then "capital" wages are but a section of service wages. Usually, too, service wages will have reference to mechanics who sometimes will work on new plant. There seems no need to take this particular point further.

Production wages may conveniently comprise all wages within a production department or pertaining to a process. These in turn call for dissection under two heads—direct wages and secondary wages. Direct wages refers to operations which form the product to some degree or other while secondary wages has reference to non-formative operations inevitably linked up with the formative operations. The distinction is obvious and the more necessary in component manufacturing when the machining operations fall in

the category of direct wages, while transport, viewing and supervision would be designated secondary wages. In a process such as plating the differentiation would be less easy, but as it happens, less essential in providing a basis for applying oncosts, which is one of the reasons for distinguishing between direct and secondary wages.

Service wages refers to labour outside that of the production department or process itself, such as plant attendance and repairs. It is possible to have, say, a belting attendant attached to a particular department, in which case his wages could be considered either as secondary (and probably more fairly so) or as service. Here again we have the budgetary control test of individual responsibility. All auxiliary labour controlled by a production department foreman should be treated as secondary for comparison with direct wages. All auxiliary labour controlled by, say, the works engineer should be aggregated as service wages, however many dissections may be made under that general heading. The control of manufacturing wages will be referred to later.

Manufacturing Materials.

Here again, there are the two broad divisions—production material and service material. Production material in turn falls into two categories: (1) Direct material, being material directly entering into the product; (2) secondary material, being material necessary to the operation or process but not directly entering into the product.

The definition of direct material is somewhat inexact because wastage of direct material, as in the form of swarf, or cuttings, is part of the direct material costs, although it obviously does not enter into the finished product. A good example of secondary material is petrol and oil used for engine tests. Service material is material pertaining to auxiliary services outside the production operations or processes. The dividing line between secondary and service material is not quite parallel to that between secondary and service wages, but the deciding factor in cost allocation is that of responsibility for control on the one hand, and measurement of real costs on the other.

Taking the petrol and oil example, if these were treated as service material to be borne as a general departmental charge, instead of being identified with the particular engine or type of engine on which used, the real cost of testing different types of engines would be obscured.

Service material pertaining, say, to plant attendance and repairs should, if responsibility rests with the works engineer or equivalent official, be aggregated accordingly and not lost sight of by being charged separately to the production departments benefitting by the material. The charge to them should be in the form of an

agreed inclusive service charge leaving the works engineer to show a profit or loss accordingly. There will not be time now to discuss the full import of this principle. The question of material control will be mentioned later.

Manufacturing Disbursements.

Although not previously mentioned, there is a class of expenditure that is neither wages nor materials. I refer to services external to the factory for which nothing tangible or measurable passes. Obvious illustrations are rates, fire insurance and employers' liability insurance. The fact that these payments may pass through the purchases books may make them technically purchases, but the respective invoices can hardly be certified by either the buyer of material or the storekeeper. Somebody and commonly the buyer does, of course, certify such invoices for payment, but their character calls for a different treatment. Some payments may be of a more confidential character, such as claims under guarantees. There is, too, the question of factory management salaries which require to come through some channel other than the wages books or purchases books.

While it is convenient to distinguish manufacturing disbursements in this way, no vital principle perhaps attaches to their separation from purchases of materials. The only principle that is involved is the recognition that these disbursements are outside the scope of any system of material control. It helps a little and costs nothing to keep them in a class to themselves.

Manufacturing Oncosts.

Manufacturing oncosts are necessarily compounded of service wages, service materials and service disbursements. There are innumerable classifications in use but, following the precedent of A. Hamilton Church, an Englishman, now in U.S.A., who wrote so ably on production factors over thirty years ago, just as in mathematics Euclid enunciated certain enduring principles rather more than thirty years ago, it will be found in line with budgetary control requirements if the following classification is adopted. I will use the terminology of my own book, viz : (1) Building service ; (2) power service ; (3) producing unit (plant) service ; (4) tool service ; (5) material service ; (6) departmental service ; (7) administration service ; (8) contingency service.

It will be appreciated that the costs under each of these heads can, for the most part, be associated with an individual. If the works engineer were, for instance, responsible for services 1, 2 and 3, it would still be desirable to maintain the sub-division as the staff employed on each would differ, and it is always an advantage to avoid any single account being for a very large amount, equally as on the other hand one would aim to avoid pettifogging analysis.

I might make the point that the contingency service referred to could cover such items as estimated guarantee liabilities on current output; claims for negligence or late delivery; reservation for bad and doubtful factory stock; development and experimental expenditure. Depreciation of building and plant is almost of a contingency nature, but it would appear as an item under services 1, 2 and 3. Its incorporation in the manufacturing accounts is a simple book keeping matter.

Oncost Rates.

All manufacturing oncosts require in the last resort to be apportioned to production departments and distributed by means of an oncost rate. Oncost rates may be worked out on a basis of time or wages. There is hardly any doubt that the basis should be that of direct time or direct wages. Sometimes the basis includes secondary wages, but this is undesirable as secondary wages have a fluctuating relationship to direct wages according to departmental activity. Sometimes direct material costs are included in the basis, but this can rarely be justified. There is something to be said for applying material service costs to material costs. This is done very arbitrarily in the printing trades, ten per cent. being added, but it can only be condoned when adopted as a trade practice or as an accepted method of arriving at selling prices.

Oncost rates may be applied as a rate (1) for the whole factory; (2) for individual departments; (3) for machine and hand sections of individual departments, or (4) for individual producing units or machines. In the last case the oncost rate is usually spoken of as the machine rate. Local circumstances must determine which method is right. There is seldom any warrant for applying a common rate to all departments, if only that for different products the proportion of work done by each department is likely to vary considerably, and so destroy the seeming justification of a flat average rate. In most machine shops it is almost essential to use individual machine rates, unless the ultimate manufactured costs of components are to be purely arbitrary. In process work, the oncost factor is necessarily a lump sum item in the total process cost and a manufactured cost per unit of product must be worked out that is inclusive of wages, materials and oncosts. Referring to machine rates again, the inclusion of an interest on capital charges, however logical it may be, imparts into the departmental results an uncertainty as to what total sum is included for interest, and comparison with the trading account results, which directors usually consult, becomes impossible.

Interest Charges.

This brings me to my promised reference to a method of recognising interest charges without including them—an apparent

contradiction. With your permission, I will quote in extenso on this point from my book:—

In considering production oncosts the question arises as to how to deal with interest charges on capital employed in production. From the financial account point of view, interest can only be met out of profits, or rather, interest on capital constitutes profits. To include an interest charge as an element of works expenses is, in a sense, to include an anticipated profit as an expense, which is fundamentally unsound. There is the other view, that if the buildings and plant were rented, the rent charged and accepted as an expense, would include interest on the capital value involved, and that it is self-deception to make no charge for rent, when the property is owned by the manufacturer. Some recognition of the capital values involved in any process is necessary, if the production oncost rates are to be equitable.

In dealing with works expenses as a whole, or by departments, the influence of interest is less disturbing than when fixing the oncost rate for individual producing units. Taking the instance of a machine of the capital value of £500, interest on that amount at five per cent. would be £25 per annum. If the working hours are assumed as being forty per week for fifty weeks in the year, in other words two thousand hours per annum, the interest charge per hour will work out at threepence per hour. Comparing this with another machine, value £50, the interest charge on the same basis would be one-tenth, that is only 0.3d. per hour—a net difference of 2.7d. per hour for interest alone.

If, however, it is held that it is not admissable to include interest on capital in the financial accounts, an interest charge can be temporarily assumed for oncost rate computation purposes, and gross individual oncost rates arrived at that will be in excess of the normal rates by the same percentage as the gross expenses (net expense plus the total interest charges assumed) exceed the net expenses. Thus, if the total capital value of machinery in a department is £5,000 the total interest charge at five per cent. will be £250 per annum. Supposing the net departmental expenses total to £5,250 per annum, then the gross expenses will be £5,500, or practically four per cent. in excess of the net expenses.

The recommendation is that the gross individual oncost rates, which include the assumed interest charge appropriate to each, shall be reduced to net rates by a flat percentage deduction—in the present illustration of four per cent. Continuing the illustration, if the gross oncost rate for the £500 machine worked out to be one shilling per hour and for the £50 machine ninepence per hour, the net rates would be four per cent. less, viz., 11.52d. and 5.64d. respectively. The ratio of the two rates remains unaltered, viz., 4 : 3, and the more expensive machine is adequately charged without the sum total of production oncosts, as applied by the net

rates, being in excess of the net works expenses, as recognised in the financial accounts.

Interlocking with Financial Accounts.

Except as an essential feature in any costing system deserving of the name, this is not the place to delve into the problem of interlocking the cost accounts with the financial accounts. It is here that the accountant " does his stuff " and, so long as the technical manager knows enough to require this interlocking to be done, he can leave its achievement properly and safely to the accountant. Perhaps I ought to say that interlocking means agreement in total. It involves adjustments of various sorts, notably of unexpired liabilities or accrued liabilities at the opening and close of any accounting period. Employers' liability insurance is a good instance. There is not only a single lump sum payment to be spread over a year's cost accounts but a supplementary payment or even refund may fall into the next year's account. The accountant actually enjoys all this sort of " finessing " to arrive at the proper cost for a given accounting period, and I daresay you will be equally happy to leave him to it.

I might refer here to the question of cost accounting periods. My own preference is for the fortnightly period as to manufacturing wages analysis, and for four weekly periods for manufacturing profit and loss statements. When we get a fixed Easter we may get the year divided into thirteen four-week months. This will hardly be convenient for half-yearly trading accounts. The fortnightly period fits in of course with the half-year division. Some firms divide each quarter into three periods of four, four and five weeks respectively. I know of one well-known firm that has used the four-week period throughout the year for many years now. As all statistical information acquires value only as it can be compared with corresponding records, the virtue of uniform accounting periods from a cost point of view needs no emphasis.

Net Production Costs.

A fundamental requirement in all costing systems, particularly in component manufacture, is that for each line of product there should be a sub-division in the cost accounts of (1) production preparation costs, covering such items as drawings, specifications, material and assembly lists, operation schedules, jigs, special tools and gauges ; (2) net production costs ; (3) defective work costs ; (4) final inspection, packing and despatch costs.

Except this sub-division be made, comparison between the costs of one manufacturing order and another is of little significance. The significance of the sub-divisions indicated will vary with different businesses, and the classification shown may not be the best possible in any given instance. The point that will apply in

every case is that the net production costs, which must be incurred for every unit of product made, should be kept clear of all non-recurrent costs, e.g., production preparation, avoidable costs, e.g., defective work, or special costs, e.g., inspection and despatch costs.

Production Wages Control.

While there are many minor points of technique in the booking of production time and therefore wages, the first essential is to have a standard of comparison, or as my friend, J. E. Powell, author of "Payment by Results" would say, "a measure of output." Every production engineer will agree that to get minimum wages costs per unit of product there must be maximum output per unit of time. To know what maximum output ought to connote requires a measure of output. This may mean time study, motion study, observation and computation. It is essentially a technical function and is not to be met by the installation of the world's best time recorder or the world's best costing system.

Measure of output is the key to efficient production. The cost records serve only to report the divergence from the standard. Actually, where a proper system of payment by results is in operation the divergence is known before wages are paid, and the cost records serve merely to report the total net score. I do not desire to belittle the costing function but only to emphasise that, in regard to production wages, control precedes the record of results.

Time prevents my touching on the principles that should underlie payment by results. I might in passing refer to the system of measuring output in terms of points. Certain proprietary claims are, I think, being made for the system, but I have used it, and probably some of you have, for many years. It has this value that, instead of having to talk of time saved under, say, a premium system (usually a most misleading statement, seeing that the time allowances have been boosted up to provide a proportional premium) it becomes possible under a point system to express the weekly output, however varied, in terms of points, and then to work out the current wages cost per thousand or other unit of points. This, of course, assumes that the points are computed on a net basis and not inflated to provide for a collective bonus system, though under certain conditions that may not destroy the basis of comparison. Whether a point stands for one minute or not of measured time matters not, so long as it has a fixed value in terms of estimated output, i.e., output "at the tool point."

Direct Material Control.

It is fairly general practice in well-run shops where the processes permit it, for material quantities to be specified in advance for each making order, and not left to the foreman's discretion. Along these lines costing becomes a summarising of known results, for the super-

vision or inspection arrangements should see that the required number of pieces are produced from the material supplied. In some industries this pre-control is not practicable and estimates of material required can only be proved against actual costs when account has been taken of material in progress.

Production Preparation Costs.

For the production engineer, the sternest test of his technical judgment is the extent to which he shall spend money to save money. In other words how far preparation costs, more particularly jigs, special tools, gauges, etc., will be justified by the sum total of resultant economy in manufacture. While it may properly be said that the answer to this problem lies both in the selling policy and production policy in respect of which the production engineer as such may have no say—though I certainly think he ought to—it still remains for him to make his arrangements to meet his firm's policy whatever it may be.

Probably the only correct way of dealing with these matters is for the production engineer to prepare a tool authorisation for each line of saleable product (that is product in saleable form whether assembled or may be as a spare part) with the estimated cost against each item. He should then prepare a statement of the net production costs for the quantity of product under consideration or on order (and possibly of alternative quantities, if a standard line) both with and without the proposed tooling equipment. He is then in a position to seek confirmation of his tool authorisation by the higher management.

All this preliminary negotiation can entail a vast amount of detail work in the way of operation schedules and tool planning, and however necessary this work may prove to be, serious delay in getting production may result from undue hesitation in putting in hand the essential tools. It may, therefore, be advisable in certain cases to deal with tool authorisation in two stages, of which one might call primary and the other secondary tools. I am, however, really not concerned to argue here just how tool authorisation should be achieved, but simply that through some suitable routine the production engineer's proposals on tool expenditure should be officially registered so that he has in effect a budget within which he is responsible for keeping. The costing system must provide for a proper record of these tool costs under each tool authorisation or equivalent, so that it may be shown whether there is a gain or loss.

The only way to be sure of recovering tool costs from the customer, and who else is there to pay unless the shareholders themselves are to be out of pocket, is to make a definite tool allowance in building up selling prices. For a given line of product the multiple of tool allowances on product actually sold should, before the

product becomes obsolete, amount to not less than the original total tooling budget. You will not need me to emphasise how considerable are the financial problems involved in deciding all the technical issues of production preparation costs. It may be enough for present purposes to register that the issues are in essence technical and that costing is a supplementary and not an initial stage. There might be, for instance, more economy in deciding not to make a tool than could possibly be saved by careful control of the making costs of the tools decided on. As to the latter aspect of controlling tool making costs the use of a labour measurement system of points or time units is quite practicable and desirable.

Defective Work Costs.

The recording of defective work costs is usually most effectively done by getting some responsible technical man to estimate the wasted material and labour from the defective work itself. Errors of judgment that may occur under this method are not likely on balance to be serious, and at least the alternative cost of an elaborate system of records is obviated. The more important aspect is to locate the responsiblity for defective work. It may be with the designer, the buyer, or in doubtless very rare cases with the production engineer, rather than with the operative.

In any case, the cost of defective work should be segregated from net production costs and, if possible, as in engineering it usually is, identified with the particular component. There is, of course, an argument for treating defective work, costs like the rain which falls equally on the just and the unjust, though the spreading of the burden does not lessen the necessity for the closest scrutiny of all defective work to prevent repetition of the defects.

Manufacturing Oncosts Control.

The most upsetting feature in all costing is the variation in manufacturing activity though it is, of course, the decline alone that gives serious trouble. This aspect is fundamental to the control of manufacturing oncosts, and without going into any detail of method, it can be safely laid down that attempt should be made to distinguish between the oncosts appropriate to a given activity and therefore to show how far current oncosts are above or below this allowance.

The same idea is expressed when the cost accountant talks of the under—or over—distribution of oncosts. Some prefer to say "unrecovered" instead of "under-distributed." Each set of terms is equally correct. Just as it is quite legitimate to talk of overheads or even establishment charges instead of oncosts. The term oncost is shorter and gives us the very concise expression oncost rate.

The real key to the control of manufacturing oncosts lies in the

fixing of responsibilities for the separate services previously mentioned. If in respect of each service the charge to each department is proportionate to that department's activities the balance unrecovered is a loss which must be remedied if the factory as a whole is to keep in step with trade conditions. This approach to control makes hard going, but any other way means that control is nominal only and results accidental rather than predetermined.

Discussion.

MR. T. G. ROSE, who opened the discussion, said that Mr. Elbourne is a very well-known figure in management affairs and, after all, accountancy plus production was more or less management. In discussing the matter from the cost angle, the author was giving a wider definition to engineering production, because it was true to-day to say that management as such is coming more and more into the limelight. One difficulty in dealing with management problems to-day was the number of institutions concerned with this matter. There was the accountancy side, the engineering side, the legal and secretarial side, and so on, and each had their own institutions and special journals, but the lines of demarcation were very vague and one of the troubles at the moment was how these various phases of management can be linked up. He expressed the hope that the Institution of Production Engineers would play its part in this work and co-operate with the various interests concerned with good management. The paper was a difficult one to open a discussion upon because the subject was so gigantic, and any particular item could be discussed for hours. Therefore, it would only be possible to deal with a few points. The author had spoken of the disadvantage of merging the manufacturing and commercial oncosts or factory expenses with the company overheads, and he agreed. There was one of the most efficient companies in this country to-day which worked along these lines, and that was essential if the main point of view in efficient management was to be kept, viz., to pin down the responsibility on the people who should carry it. It was wrong to mix up selling charges with manufacturing charges and make them one large item. The author had adopted a rather sarcastic point of view with regard to accountants as a whole, but it must be remembered that the accountant was held to definite book figures, and he developed an outlook which was based on the balancing of his figures. Where, however, the accountant seemed to fail at the present time was that he did not appear to be capable of presenting his accounts to the people who had to use them in a form which enabled those people to see what they wanted from their point of view.. What was wanted was something more than a profit and loss account or balance sheet, and it was here that the cost accountant and production engineer could work together very

effectively. The production engineer wanted a plain statement of what costs were going up or down, and where the accountant could be of much more service to the production engineer than he is, was in providing a statement which gave the production engineer the information he desired to have, and not a statement made out from the accountant's point of view.

With regard to machine rates, had the author seen the short article by Mr. Dudley Forman, of Nottingham, dealing with this matter. It was a problem of great interest to works managers in relation to replacing an old machine by a new one. It might be that an old machine had been written off in the books to say £1, and was still in operation. The machine hour rate was extraordinarily low, but very often it was the type of machine that only one man knew how to operate or look after, and it was a case of waiting for "Jack to come back," before anything could be done. Therefore, such a machine was very slow. When such a machine was replaced by a new one costing perhaps £1,500, the machine hour rate went up, but the actual cost per piece was lower. There had been cases, however, in which it had been said that because the machine hour-rate went up, such a machine could not be used. He would like the author's opinion on the method of calculating machine-hour rates set out in the article to which he had referred.

THE AUTHOR expressed his approval of what the last speaker had said with regard to co-ordination between the institutions representing the various phases of management.

He did not, he said, intend to be sarcastic about accountants. The position was that any faults attributable to the accountants were due to the fact that the production engineers had often left them to do the engineer's job in costing as well as their own. In U.S.A., the great progress in the science of works costing, particularly under conditions of mass production, was due to the initiative of the production engineer and his cordial collaboration with the cost accountant. Personally, he got on very well with accountants and had always got what he wanted when he told them how he wanted it. He had not seen the article on machine hour rates mentioned by Mr. Rose, but would be pleased to follow it up.

MR. GERALD SMITH said it was very important that engineers should get the costing into their own hands and, although speaking as one who was no longer a production engineer, if the author could start a society for kicking the accountant out of the works, he personally, would be delighted, because the accountants too often gave what the engineers did not want. He did not like the author's suggestion of a flat charge to a department for service, because the departmental managers could effect the cost of these services very much indeed. He would like to see, if possible, the true debits to each department, particularly for machine repairs, etc., because whilst one man might tear a machine to pieces in working, another

would look after it.

THE AUTHOR replied that the point with regard to changing each department for services was quite good, except that it might not fit in with the definite apportionment of financial responsibility. It was for the service department, responsible for keeping the machinery of each production department in good order, at what might be thought of as a contract price, to take up any question of ill usage of machines. It might be good business of course to tax a machine up to nearly breaking point if the increased output per unit of time justified it. The service charges would have to reflect the heavier depreciation and upkeep costs involved in this policy.

MR. R. H. HUTCHINSON said that the author seemed to him to imply that technical men are more interested in systems than in underlying principles. His own experience had been that the purely technical man abhorred system and generally wanted to get on with the technical side of his job. A man who was thoroughly technical in mind was not as a rule systematic of mind so far as works systems were concerned. For this reason, he himself argued, that the matter of costing is one for the works accountant. It was for the works' accountant to dish up to the production engineer the information he required and the production engineer should not govern the works accountant, except from the point of view of saying what was the information which would be of greatest value to him. In one part of the paper the author remarked that production engineers often said that a particular system was all right but that it did not fit his own particular department. A little later on reference was made to apportioning costs to certain departments or operations, and plating was mentioned. But surely the method adopted depended upon the volume of plating compared with the total output of the factory. If the factory was engaged in selling cheap pressings, highly plated, then obviously the question of the on costs for the plating department became very important, and this showed how justified the production engineer was in saying that one particular system did not necessarily fit all cases. The particular system adopted depended entirely on the nature of the product, the quantity, geographical surroundings of the works, and many other details of that character. Then the author spoke of non-productive labour and even included the staff under that heading. His own experience had been that the staff was always considered a special item and should certainly not be referred to as non-productive labour. Also he makes no provision for necessary so-called non-productive labour. Productive labour working on any system of payment by results must have a certain amount of non-productive labour, such as inspection, transport, etc., working with it, essential for the completion of work passing through various operations. The point was that as productive labour went down, so this non-productive labour went down in proportion. From this point of view, therefore, he

contended that the author's use of the term "non-productive" labour was a bad one, but the general meaning of "non-productive" labour in the way he himself had explained it was a good one.

MR. ELBOURNE took exception to some of the conclusions Mr. Hutchinson had reached. For instance, he certainly did not mean to imply that plating oncosts were ever unimportant. He merely meant that distinction between direct and secondary labour was not as important when costing plating as when costing, say, machinery. As to describing any labour as non-productive, he confirmed his opinion that as a term it was objectionable and unnecessary. The issue, therefore, of whether staff should or should not be included under that heading did not arise so far as he was concerned. It had been his endeavour to draw the attention of production engineers to the fundamental principles that, in his long industrial experience, they needed to understand if they were to reach the standard of co-operation with cost accountants which he hoped for—a co-operation that should be based essentially on mutual respect and agreement as to the function of costing, in achieving an all-round greater efficiency in British industry.

MR. E. W. HANCOCK, Chairman of Council, said he wished to thank the author for his paper, as it included important matter relating to costs, and permitted members of this Institution discussing a subject which was vital to production engineering. Certain criticisms had been levelled at the lecturer in so far as the opinions raised generalised too much, but he felt that this was welcome in so far as the Institution wanted to cover all phases of production engineering. Mr. Hancock continuing, said that the works accountant in any organisation was one of the best friends of the production engineer, and there was no doubt that if these two functions understood each other's problems, the question of achieving sound control of costs in the works was facilitated. A proper system of cost control in the works is one of the most important factors in assisting to gauge efficiency. In discussing production methods at a meeting such as this, participants are rather apt to forget that production methods must be based upon policy of a particular company, and what he wished to make very clear, was the importance of introducing the best production methods depending upon the policy of a particular company. In Mr. Elbourne's paper, the statement was made to the effect that "by costing is meant the building up of records of what has happened, whilst estimating refers to what in certain circumstances is expected to happen." Mr. Hancock observed that the first was virtually the past, and the second was the future, but what he was concerned about was, "what about the present?" and he expressed the opinion that he thought the paper might have given more time to this particular subject. The most important use of a works accountant is, signifying to the works department the trend of costs, so as to give them

an idea as to the way in which they are running in sufficient time for them to make the necessary modifications in order to keep within their budget allowance. He felt that this one one of the most important functions of the works accountant in placing information in an understandable manner before the works, as the chief object of the works accountant's department was to help the works to be within their budget allowance, and not to tell them when it is too late, that they have exceeded their allowance. In conclusion, Mr. Hancock again directed the members' attention to the importance of production engineers, making a study of the question of cost control, and the importance of production engineers working in close association with works accountants.

Mr. C. H. Appleby, speaking as one of the much maligned accountants, said the task of the accountant was to provide figures for those in the best position to use them, and they were the works manager and the directors. At the same time, through the engineer and the accountant not working sufficiently well in hand, the engineer did not always get as much information as would be useful to him.

Mr. A. J. Hawkins, also speaking as an accountant, said there was no use the works accountant producing statements of figures which nobody required. In several firms it was the practice for the cost accountant to tell the production engineer in the morning, what he had done the day before, but that was only possible if the production engineer came along and stated exactly what he wanted to know. Where the general manager or production engineer did not get the information he required, it was purely his own fault. The production engineer did not like producing parts which nobody wanted, and the sales engineer did not like having to try and sell things which he knew the public did not want. Equally, the works accountant did not produce figures that were not wanted, but if it were indicated to him what would be useful, then the information would be forthcoming.

The Author again emphasised that he had not intended to—and did not think he had—belittle the accountancy profession, nor did he suggest the production engineer should take charge of cost control. He merely recommended that the production engineer should control what records were to be made, and not the making of the records themselves.

Mr. Salmon urged that some system of costing should be devised which would eliminate a great deal of the paper records now necessary. He also asked how the author would deal with defective work, a very important item in production costs.

The Author said he had pointed out that defective work involved too much system to get it out as a separate record system. Therefore, the better thing to do was to take it as an estimate from the engineer. The question of the many paper records often used would largely solve itself when the production engineer and the works accountant worked more closely together than they do at the

present time.

MR. COX said that in the system in use in his works one paper now took the place of six used formerly, and the production engineer was supplied with figures every 24 hours.

MR. HUTCHINSON proposed a vote of thanks to the author, which was adopted with cordiality.

A COMPARISON OF SHOP PRACTICE IN GREAT BRITAIN, AMERICA AND THE CONTINENT, WITH AN INDICATION OF WHICH IS CONSIDERED THE BEST.

By H. Mantell (Member)

(*Paper awarded the Prize presented by the President, Mr. Tom Thornycroft, in the Prize Competition of* 1930-31).

AN essay, especially one venturing to draw comparisons, demands an indication of the author's credentials. This particular writer has an intimate knowledge of engineering practice in Great Britain—a superficial personal contact with shop practice in Germany but has not yet visited America. Thanks to an extensive acquaintanceship amongst American and German engineers, amplified by the technical press, knowledge need not be bounded by personal experience. Therefore, the comparisons which follow are based upon as much actual fact as can be determined without journeying to make personal investigation.

Before the full significance of any comparisons can be appreciated, it is necessary to take note of any external factors. For instance: the subject "Shop Practice" is only one phase of the commercial activity described, generally, as business and its functioning will depend upon the policy governing the whole. This is worth a brief review. Business may be broadly divided into the following groups: (1) Financial Control; (2) Buying; (3) Manufacturing, and (4) Selling. The last three certainly depend upon the first, whilst all of them are, in greater or lesser degree, inter-dependent.

In considering this side of the subject, undue regard must not be paid to the existing slump. The causes of this lie outside the realm of pure business as is witnessed by the fact that all countries, embracing the exploitation of many different theories of conducting business, are similarly affected. It may be that it will be found that the practice of one particular theory endows the exponent with more rapid recuperative powers but this can be taken as a happy incident rather than the justification of the theory, none of which was formulated to allow for a world-wide breakdown in the exchange of commodities.

Returning to the comparison. In America financial control is largely by means of a budget. This is prepared to cover a period sufficiently far ahead to permit of the development of a definite programme, and is based upon an elaborate market analysis coupled with statistics of cost which are founded on actual fact or upon the findings of costs engineers. The advantage of this system lies in the fact that, once a budget has been sanctioned and arrangements made

to finance it, everyone in the organisation can plan with a definite objective in view, whilst the directors and designers can develop a policy for the next period ahead without uneconomic haste.

This is possible in a country with an assured market, but is more difficult to nations largely dependent upon export trade. France, due to political reasons is probably better able to follow this scheme, but its benefits, as far as the manufacturing side of business is concerned, cannot be utilised to the full because other reasons prevent that country from becoming a large engineering nation. Germany has for many years looked to her government to finance business, either directly or through State-connected banks. This has enabled her business men to prepare a budget from which the manufacturing element must derive benefit, this is, however, largely off-set by the imposition of "cardindexitis" at its worst—a condition seemingly inseparable from association with public funds. Great Britain still remains the world's largest exporter of engineering products and, because of the many markets she serves, a definite policy extending over a period is difficult to achieve. This is not an insurmountable obstacle, and production engineers look to business men to arrive at a solution because, by doing so, they can do much to diminish costs of production. As things are, policy is of the hand-to-mouth (or, to be more precise, Board Meeting-to-Board Meeting) order and this condition makes it difficult to prepare a programme of improvements in plant or methods.

Buying can affect production costs to a tremendous extent; it will be noted that total costs are not referred to in this instance but they are usually concerned. In the first place, indications point to American and German practice tending, very rapidly, to the policy of buying against the specification of the purchaser rather than to the trade description of the seller. This, in itself, places the shops in a favourable position in that the cause of much scrap and disorganisation is eliminated when the performance of materials and tools can be forecast. Uncontrolled, this method of buying would lead to an unwieldy multiplication of specifications, but both America and Germany have tackled this by the formulation of standard specifications as far as material is concerned, and America, by allowing the production engineer the choice of tools, which choice he is, from time to time, called upon to justify on a "cost per piece produced" basis. In Great Britain these advantages are not so apparent and, to effect an initial economy of a few pence, the production engineer is often called upon to spend shillings.

The Sales Policy in general use in America tends to improve shop practice, for, after conducting a Market Analysis, it commits the Sales Department to the task of disposing of goods produced to a production programme, *i.e.*, the production engineer knows some time ahead the quantity of goods of a definite design which he will be called upon to manufacture in a set period.

This practice is only adopted in a very few cases in Europe, demand is catered for rather than created or revealed, so that manufacturing sanctions cover smaller quantities and embrace shorter periods.

The foregoing is an attempt to indicate some of the major factors which influence shop practice. Whilst they are outside the control of the production engineer they have a distinct bearing upon the methods he must adopt to grapple with his problems. External factors such as these react in favour of the shops in America and, to that extent, give American shop practice a flying start in comparison with the Continent in general and Britain in particular.

Turning to actual shop practice, consideration must be given to the labour question. To produce a given result America uses more power and less labour than either Germany or Britain. This is not due to wise men saying, " Let us ease Humanity's burden," but to the clever men exclaiming, " If labour demands so high a figure for its services, we must displace it." However, the economic motive has led the world some way along the path towards the humanitarian ideal and demonstrates that sometimes a wrong (or selfish) action will, by happy accident ultimately result in good. At this point the author would like to record his conviction that, despite present-day evidence to the contrary, there is no question of saturation. Tremendous territories still need roads, bridges, railways, vehicles, homes, sanitation and other essentials, whilst these, in their turn, will cultivate a demand for modern amusements. America has been particularly blessed in possessing conditions which foster the cultivation of such demands. Immigrants who, in their own country, bowed down to the dictates of organisations which postulate the theory that " The reward of all shall be measured by the capacity of the least efficient," arrived in America expecting it to flow with milk and honey for those who would work—and they worked to bring their expectations true. In effect America has said, " They who will not labour neither shall they eat." In return Labour has replied, " We will work to eat and to improve our lot and our reward must permit of this." From this attitude, America discovered that wage rates are high per person but low " per piece produced " because the operatives will co-operate in obtaining the highest efficiency from any mechanism which will increase their reward. The high wages permit the greater consumption of manufactured goods, so that, instead of machinery reducing the number employed it creates fresh industries to supply the needs of a more comfortable standard of living.

Hours of labour vary in each country. Britain with a 44 hour week, being apparently the least industrious. In Germany a 48 hour week seems to be general, whilst America works a 48 or 52 hour week, excepting in those plants where the two or three shift system is in vogue. In any case, both America and Germany find

Labour ready to help in the act of condensing the working life of machinery into as short a period as possible, therefore, allowing plant to be scrapped on an economic basis in order to make room for up-to-date equipment.

It must not be thought from the above that either German or American workshops are equipped with nothing else but new machinery. This is not so: the practice, more fully developed in America, is to keep the "key" operations tuned up to the highest degree of efficiency and gradually passing the older equipment to minor purposes if it can so be used. If not it is sold to smaller firms or to foreign countries, who, by purchasing, help to finance the plant improvement programmes of their competitors in the international market.

Works practice must embrace Works Organisation. America organises only to increase profits, and in doing so employs a large amount of "non-productive" labour. (The inverted commas are used because labour usually so described can, if intelligently directed, be extremely productive even if it never comes into physical contact with the goods in course of manufacture). Germany organises, partly to satisfy the national trait of discipline, partly to satisfy the demands of the financial departments of the State for a check on expenditure and partly to increase profits. Britain organises as little as possible, mainly because of the spasmodic way work goes through the shops due to the policy of manufacturing to demand. This means that America, by good staff work, is enabled to make the fullest use of the resources at her command. Even in the preparation of raw materials she is placed at an advantage. The phrases "American cast-iron" and "British cast-iron" infer two different substances. Actually what is implied is a difference in machining qualities, other physical tests reveal that the American cast-iron is equal to the British. Yet another advantage is the closeness-to-size achieved by American foundries. Before foundry work was raised to a science there may have been an excuse for large machining allowances; unfortunately, this practice has been hallowed by tradition in Britain, whilst in America every improvement in foundry practice has been made to operate in favour of the machine-shop. This question of machineability extends to all materials; the Americans are not satisfied to produce an alloy which will give the physical results demanded by the designer, but, with that almost as a starting point, continue their researches until the alloy is rendered as amenable as possible to fabrication.

From the raw material, the next consideration is the method of converting it into the finished product. America and Germany, in the order given, always endeavour to reduce machinery to the utmost. In the past this has been achieved by omitting to machine "not essential" surfaces: a detrimental practice, for the machining

of a part that is not a mating surface is often the means of releasing casting stresses to the ultimate good of the product. The current practice in both countries is to use pressings and welding as much as possible, with a consequent reduction in production costs.

In all these countries machining is veering away from the complicated set-up which consisted of securing the piece being worked upon and performing as many operations as possible before releasing it. Assuming 100% efficiency, this is an ideal arrangement for it conserves setting time and floor space ; the disadvantage lies in the fact that the machines were complicated and the sets of tools seldom " broke down " at the same time, therefore, idle time—especially with such necessarily expensive equipment—added to the production costs out of all proportion to the benefits achieved. Current practice in America, Britain and Germany (placed in order of merit) is to subdivide operations so that they can be performed on simple machines requiring the minimum of attention. On such machines as lathes and millers, American practice is to mount the tools on removable blocks or on arbor assemblies, then when sharpening becomes necessary, the block or assembly is taken to the Tool Room for treatment and a duplicate installed in its place. This is not general practice in Europe where the machine operator is called upon to re-grind and re-set lathe tools and to re-set milling cutters. The worth of either method can be determined by simple calculation, but as the American method necessitates a greater capital expenditure, it is seldom investigated in Europe beyond that point. There is, however, some merit in the European practice, in that it makes the plant more flexible at lower cost in order to deal with changes of design. This, however, is an indictment of the Sales Policy rather than a commendation of the production department.

A definite advantage of American practice is the full exploitation of the line method of production. In plants engaged upon large outputs this becomes the " flow " method in which the material seldom touches the floor or is allowed to rest (excepting during machining) in its progress through the shops. There is a noticeable tendency in America to manufacture machine-tools with a standardised dimension between the floor and the work table, this is generally described as conveyor height.

It is claimed that individual motor drives with the consequent mobility of the machines assist in line production in that a rearrangement of the plant can be effected readily. This claim is contested, for even if not motor driven, most machines of recent date are equipped with single pulley drive and to change the position of a pulley on the line shaft is not so troublesome as rewiring one or more motors. Admitting for the moment the superiority of the individual motor drive in assisting in the layout of a shop for line production,

it is interesting to find that the order of the nations is as follows :—

Line Production	Individual Motor Drive
America	America
Britain	Germany
Germany	Britain

Economy in power, improvement in lighting, with a lessening of accidents and lower plant maintenance costs are the principal advantages of individual motor drive, yet Britain, with its heavier charges for power, lags behind the other countries in adopting this method. It is unfortunate that the suggested standardisation in this country should be fixed at 50 cycles, whereas the existing standardisation in America and Germany is on a 60 cycle basis. Not only does this tend to prevent an interchange of electrical devices, but of more serious import, it will handicap Britain in the export market. Already competitors, with a lower production cost, due to standardisation, are establishing a demand for 60 cycle equipment : when she is ready to enter the field, Britain will offer 50 cycle equipment as standard " . . . . . and if you don't like it, 60 cycle will cost you more ! "

Reference in an earlier paragraph to conveyors shows another advantage of American practice. Mechanical handling has arrived in America and is gradually increasing in use in Britain and more slowly in Germany, the relation being in ratio to the wage rates in the respective countries. In any case, it is bad to use a human being as a beast of burden but, apart from the ethical aspect of the question, there is the fact that mechanical handling and conveyor progressing keeps down the accident expenses account whilst lessening the damage done to work in transit. It also tends to keep machines fully occupied, there are few greater incentives to shop discipline than to have a reasonable amount of work to be done in sight of the machinist and further, a mechanical device does not indulge in those little interludes of horse-play which serve to distract attention and slow down production. Any means—and mechanical handling is one of the greatest—which helps to get material through the shops in a minimum of time is to be commended, for by these means the very real, but generally unappreciated, cost of financing work in progress is considerably reduced.

It may be remarked with justification, that the foregoing is applicable to the manufacture of articles which are produced in reasonably large quantities. Certainly the full effect of the advantages is felt in such circumstances, but the underlying principles can be used in shops laid out to deal with a diversity of sizes or a variety of products. In all of these cases there is either a similarity in the pieces being produced or a repetition of the manufacture of certain parts at intervals. It is only in the shops that are engaged in general engineering in the true sense of the expression that some form of line production cannot be utilised.

This latter form of engineering can be dealt with by the statement that shop practice rests, almost entirely, on the ingenuity of the foremen and the all-round skill of the mechanic. Plant in any of the countries is chosen for its universality rather than its ability to perform any one function expeditiously, but Germany, of the three countries, offers evidence of a demand for plant to save time even on "one off" manufacture. Marking-off and machine manipulation times are important factors in the general engineering field. The first is difficult to reduce, but the second can be lessened by the use of machine tools designed to include power rapid traverse to all tool slides, quick change gear boxes to alter feeds and speeds to suit the varying dimensions which are likely to crop up on one component at one setting, hydraulic motions (especially on grinding machines to speed up traverse without shock at reversal), the fitting of Vernier scales and many other features all tend to reduce floor to floor time. In this respect there is also a marked tendency in Germany to use tungsten-carbide cutting tools in general engineering practice ; machines are already on offer especially designed to take full advantage of this material, and if supply is indicative of demand, then Germany is certainly ahead in this particular, Britain next with her mechanic's greater skill and America occupying the third position.

Articles which are produced on a semi-repetition basis cause works practice to be more favourable in America with Germany second and Britain last. Both America and Germany follow the line method of production (in this grade Germany and Britain change places, for in the plants where large production is called for, Britain appears to have adopted the line method with greater thoroughness) and American plants benefit by the plant passed down by the high production shops and also by the general trend of machine tool design being directed towards the standard set by the demands of the mass producers. Apart from producing machine tools this demand also engenders a state of mind throughout the engineering industry in America. This is attuned to investigate new methods and to adopt them without waiting for the guarantee of 100% efficiency which is usually demanded by the European. Because of this, shops engaged upon moderate production may be found to contain more up-to-date plant bought, not to replace worn-out plant, but to arrive at a standard set by the progressive attitude of the whole industry.

Probably because of the high cost of labour, jigs and fixtures are also more highly developed in America than in Britain or Germany. The demands of industry have brought into being a section of designers specialising in this field in America, British shop practice is also being improved by a similar, but slower movement in this country, whilst Germany does not appear to be paying the subject the attention it warrants.

Shop practice is, in the end, dependent upon the human element. The extent to which responsibility for speed and accuracy can be vested in a mechanical device is a measure of successful administration and, in doing this, America leads, with Britain and Germany adopting the principle as quickly as the production engineers in those countries can convert the holders of the purse strings. (In some cases the position is reversed, *i.e.*, the higher powers are frustrated in their efforts to mechanise their shops due to a non-progressive, tradition-ridden works executive). But when all this has been done the makers of jigs and fixtures and other tools depend upon manual skill for their success. The less progressive general machine shop methods adopted in Europe tend to raise the general level of skill of those employed in the engineering industry, so that proportionally, Britain and Germany have a large field for recruitment. This is not a justification of out-of-date methods. To overcome their disadvantages America is developing, or re-developing, a race of toolroom mechanics and even in the toolroom she is introducing plant, whereby the handicraft of the oldtime toolmaker is being reproduced mechanically.

At present, and in this order, the virtues in machine shop practice of the countries may be summed up as follows :—

Mechanic's Skill.	Lowest Cost per Piece Produced.
Britain	America
Germany	Germany
America	Britain

That " the piece produced " is not always in conformity with the requirements of the market is the salvation of Britain, whose better pure engineering work, coupled with a greater elasticity of production methods allow her to make the most of opportunity thus presented. But—and it is an important " but "—this opportunity is gradually being sapped by her competitors' intensive Market Research and propaganda directed to persuade overseas markets to accept a standardised article in view of its lower costs and better servicing. It, therefore. behoves every British production engineer to gradually adopt those proven better methods so that his nation can enter a new era of industrial prosperity.

In conclusion : will the reader scrap whatever notes have been made refuting the claim that one country is better or worse than another. These remarks are based on general practice, and it is recognised that in all countries there are reactionary forces as in all countries there are progressive firms. A country is represented by its average.